



# Our Blood Your Money

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Medical History

## Our Blood Your Money

John Hedley-Whyte, Debra R. Milamed

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### SUMMARY

On June 3, 1939, Donegal-born James C. Magee was appointed U.S. Army Surgeon General by President Franklin Delano Roosevelt. On May 31, 1940, Magee appointed Professor Walter B. Cannon of Harvard University as Chairman of the U.S. National Research Council Committee on Shock and Transfusion. In 1938 Brigadier Lionel Whitby was appointed Director of an autonomous U.K. Army Blood Transfusion Service (ABTS). Whitby thereupon appointed Professor John Henry Biggart, Professor of Pathology, Queen's University, his Northern Ireland Head of Blood Transfusion and Blood Banking. Winston S. Churchill was aware that Biggart's service would be responsible for the needs of the Allied Forces and later for the United States Forces in Northern Ireland. Professor J.H. Biggart was known to Churchill from their 1926 post-prandial encounter in Belfast. The United States in 1941 determined that they were not able or prepared to fly U.S.-donated blood to Europe or Africa. The shortage of whole blood for United States forces required Whitby's ABTS to supply all the blood for the Mediterranean Theatre and in Europe from the St. Lô breakout from Normandy until after the capture of Brussels on September 3, 1944 and then again in December 1944 for the Battle of the Bulge. Winston S. Churchill took Whitby to Quebec in September 1944 to meet with President Roosevelt and the combined U.S. Chiefs of Staff. Churchill used the supply of British blood to meet the needs of American Forces to prevent the U.S. threats to bankrupt the British Empire. President Roosevelt, already involved in his fourth campaign for the U.S. Presidency, accepted most of the British proposals for further credits. By Okinawa in the spring of 1945, under ABTS tutelage, all the Allies were adept in long-range transport and storage of large, 100,000 pint quantities of whole blood. Subsequently, Whitby and John Henry Biggart were knighted; U.S. Army Surgeon General Magee was sacked.

### INTRODUCTION

The principles of World War I blood banking were continued during the Spanish Civil War by the Blood Transfusion Services of the Spanish Republican and Nationalist Armies. The Republican service included 28,900 donors and used citrated and stored blood in a manner similar to "Robby" Robertson's blood banks during World War I<sup>1-3</sup>. The Nationalists were advised in Spain by Oxford's Nuffield Professor of Anaesthesia Robert Macintosh (Fig. 1), and by

Dublin-born and Yale-trained Joseph Eastman Sheehan, Lord Nuffield's choice for Professor of Plastic and Reconstructive Surgery<sup>5</sup>. Elósegui's Nationalist Blood Transfusion Service transfused an estimated 25,000 times before Franco's victory<sup>6</sup>.



*Fig 1.* Professor Sir Robert Macintosh and Angus Hedley-Whyte examining at the first examinations in 1952 for the Fellowship of the Faculty of Anaesthetists of the Royal College of Surgeons of England. Photograph 1952 gift to John Hedley-Whyte. Sir Robert was fluent in Spanish from his internship in Montevideo. Both Sir Robert<sup>4</sup> and Professor Eastman Sheehan<sup>5</sup> were friendly with Nuffield Professors Hugh Cairns and fellow Nuffield Professor Republican Catalan hero Joseph Raspall Trueta, an orthopedic surgeon. Both Professors Macintosh and Sheehan were awarded the White Cross of Military Merit by Franco<sup>6</sup>.

In 1938 the British, in preparation for another war, formed, at the instigation of the Royal College of Surgeons of England, an autonomous Army Blood Transfusion Service (ABTS) under the command of Brigadier Lionel E. Whitby<sup>2,7</sup>, already well-known for his successful treatment of King George V and his introduction of sulphonamide treatment into Britain<sup>8-10</sup>. Whitby had also been advisor to the Massachusetts General Hospital in the successful treatment of Franklin Delano Roosevelt, Jr.'s serious pneumonia<sup>11</sup>. Whitby obtained the services of his physician wife, Major Edith, as his executive officer and urged the appointment of Geoffrey Keynes to be

David S. Sheridan Professorship in Anaesthesia and Respiratory Therapy  
Harvard University, 1400 VFW Parkway, Boston, MA 02132-4927 USA  
Correspondence to Prof. Hedley-Whyte  
john\_hedley-whyte@hms.harvard.edu

Surgical Consultant to the Royal Air Force<sup>12</sup>. Lionel Whitby writes Oswald “Robby” Robertson “stored blood for as long as 21 days and used it with excellent results in the treatment of wound shock on the battlefield,” where it was indirectly transfused during World War I<sup>3</sup>. Whitby continues, “It is difficult to understand why [Robby] Robertson’s [and Colonel Professor Andrew Fullerton’s] remarkable achievement remained forgotten for nearly twenty years till the Spanish Civil War in 1937-39”<sup>3</sup>.

The Whitbys arranged close collaboration and their ultimate control of the U.K. Emergency Medical Services’ blood donation and banking. For Northern Ireland, Queen’s John Henry Biggart, Professor of Pathology since 1937, was the Whitbys’ obvious choice for Director and Blood Transfusion Officer for Northern Ireland<sup>13</sup>. Biggart had written about blood<sup>14,15</sup>. He got on well with Professor Thomas Houston whose World War I blood banking with “Robby” Robertson was by now well known<sup>16</sup>. Moreover, Biggart had been a Harkness Commonwealth Fellow at Johns Hopkins for two years and had toured throughout the United States<sup>13</sup>. The U.S. forces due to be deployed to Musgrave Park were scheduled to, and arrived in 1941 and 1942, without U.S. blood banking facilities. From 1940 Angus Hedley-Whyte (RAMC) and Colonel Thomas Lanman’s (U.S. Army Medical Corps) Musgrave Park surgical services<sup>17</sup> were to rely on Biggart’s blood donors obtained through the Northern Ireland Transfusion Service of the U.K. Emergency Medical Services.

Geoffrey Keynes, in 1940 about to be Air Vice Marshall, arranged the recruitment of Dr. Gerry Nelson from Biggart’s Queen’s Pathology Department to the Royal Air Force (RAF)<sup>2,13</sup>. Winston S. Churchill as First Lord of the Admiralty, was told that Biggart’s Service would provide blood for the Royal Navy, Merchant Marine and the U.S. Navy. Lionel Whitby later recounted to Churchill, now Prime Minister, of Biggart’s post-prandial hazing of Churchill following the latter’s 1926 Queen’s honorary degree. Winston Churchill had been seized by Biggart’s fellow students, “crowned with an Irish paddy hat with green ribbon, given a white clay pipe and placed in an Irish jaunting car.” Before Churchill marched a cohort of Hibernians, suitably bedecked, with John Henry Biggart in charge, writes Biggart’s son Denis<sup>18</sup>.

During the 2nd British Expeditionary Forces’ retreat from France in 1940, Whitby’s service provided approximately 4,000 pints of whole blood<sup>2,7</sup>. As a result of the experience of both BEF’s in World Wars I and II, and the fighting in Norway, it was estimated that 41.4 pints of blood would be needed for every 100 Allied wounded<sup>2</sup>. Whitby informed the U.S. Surgeon General of the Army, Major General James Magee, of this estimate through his liaison officer in Washington, D.C., Colonel Frank S. Gillespie, R.A.M.C.<sup>19,20</sup>.

## US DISPUTES

Donegal-born General James Carre Magee between 1939 and 1943 commanded a corps of 30,000 U.S. doctors as well as 20,000 nurses<sup>21</sup>. While on a tour of Allied Forces in the

U.K. and Africa, his superiors U.S. Chief of Staff George C. Marshall and Lt. General Brehon B. Somervell, Commanding General, U.S. Services of Supply convened the Sanford H. Wadhams Committee to review “the organization and administration of the [U.S. Army] medical department”<sup>22</sup>. Chief of Staff Marshall and General Somervell were not convinced of the capability of the Office of the Surgeon General to manage wartime challenges, as the Surgeon General’s Office had objected to limitations on personnel and supplies they had imposed<sup>22</sup>. Evarts Ambrose Graham, Professor of Surgery, Washington University, St. Louis, Missouri, and Dr. Lewis H. Weed, Director, Medical School, The Johns Hopkins University, were members; in addition, six civilian doctors and two retired U.S. Army doctors were added, as was only one layman, Corrington Gill, an economist and statistician. Secretary of War Colonel Henry Stimson announced the formation of the Wadhams Committee the day before its first meeting on September 25, 1942, and Surgeon General Magee was thus informed while on his UK and Africa tour of inspection<sup>22</sup>.

The Allied Commanders and Surgeons with whom he met during this tour continued to emphasize the need for U.S. whole blood<sup>23</sup>. Surgeon General Magee saw that the Whitbys’ ABTS was doing an excellent job of supplying whole blood for the Allies in Africa. In early January 1943, General Magee asked for a copy of the complete Wadhams Committee Report. Next month, February 1943, Lewis H. Weed and Evarts A. Graham insisted on seeing the U.S. Secretary of War Henry Stimson. Former U.S. Surgeon General Merritt W. Ireland also complained to General Marshall of “aggressively critical attitudes toward the Medical Department...and of the failure to release the Report”<sup>22</sup>. On June 1, 1943, Magee was relieved of his Surgeon Generalship. The replacement nominated by George C. Marshall and President Franklin Delano Roosevelt was unacceptable to the American Medical Association; it being the start of his re-election campaign, the President accepted the American Medical Association’s candidate Norman Kirk, an orthopedic surgeon<sup>21</sup>. Magee had paid the price for requisitioning too many hotels and having Military Police arrest U.S. prostitutes to reduce U.S. Army rates of venereal disease<sup>22</sup>.

At the request of Surgeon General Magee, Walter B. Cannon, Professor of Physiology at Harvard, who had advocated the use of gum acacia during World War I, chaired the U.S. National Research Council Committee on Shock and Transfusion<sup>19</sup>. By November 3, 1941, this committee agreed “that it had been the consensus of the group that [US] Armed Forces should use whole blood in the treatment of shock wherever possible”, but the results of that discussion were not officially minuted until two years later, on 17 November 1943<sup>19</sup>.

## D-DAY PLANNING

On Friday, March 5, 1943, at Thirlestaine Hall, Cheltenham, the D-Day Casualty Planning Committee, including Brigadier Angus Hedley-Whyte, was told that at least 30,000 pints of



group O whole blood would be needed for D-Day and the following month, on Whitby's advice, based on the previous year's experiences at Gazala-Bir Hacheim, Alam Halfa, and El Alamein. Col. Elliott C. Cutler's memorandum dated March 27, 1943, to Brigadier General Paul R. Hawley, Chief Surgeon, European Theater of Operations, stated that "Brigadier Whitby tells me that the use of wet plasma has practically been given up, and transfusion used in its stead in the British Army"<sup>24</sup> (Fig. 2). The Allied planning group were shocked to be told that the U.S. would not sanction the transport of any whole blood from the United States to Great Britain; logistical problems and the efficacy of human



Fig 2. Portrait of Elliott Carr Cutler, 1946, by Charles Sydney Hopkinson (1869-1962). Oil on canvas 124 x 90 cm (49 inches x 35.5 inches). Reproduced, with permission, from the collections of the Brigham and Women's Hospital, Boston, MA. Photography by Susan R. Symonds, Mainframe Photographics Inc., Brigham & Women's Photographic Services.

Elliott Carr Cutler was born in 1888 of Puritan stock. He graduated from Harvard Medical School before World War I. He further trained in 1913-14 at Heidelberg, and thereafter served as a surgical mainstay of Harvard's 5<sup>th</sup> General Hospital<sup>25</sup>. Cutler's 1923 mitral valve split was "The first successful intracardiac operation in the world..."<sup>26,27</sup>. During World War II he was responsible for planning the overall treatment of the wounded in the European Theater of War<sup>25</sup>. His 1947 British Journal of Surgery obituary is laudatory: "Perhaps no surgeon of the United States ever yearned or strove more earnestly to forge lasting bonds of friendship...between the peoples of the great English-speaking countries on either side of the North Atlantic"...Integer vitae scelerisque purus"<sup>28</sup>.

plasma were cited as the reasons for the U.S. obduracy<sup>19</sup>. The fractionation of whole blood and production of wet and dry plasma had been described and overseen by Professor Edwin J. Cohn of Harvard Medical School<sup>29,30</sup>.

Col. Edward D. (Pete) Churchill of Harvard University and the Massachusetts General Hospital was incensed by the Surgeon Generals', Magee's and from June 1, 1943 Kirk's positions. Col. Churchill briefed a New York Times reporter with the aim of publicizing the need for military blood banks<sup>31</sup> (Fig. 3). Pete Churchill was Chief Surgical Consultant to the North African and Mediterranean Theater of the War, in an Allied Command Structure with the Whitbys' ABTS providing blood as needed. Pete Churchill thought Brigadier Whitby's service invaluable and efficient and thus informed his successive theater chiefs D.D. Eisenhower and Ulsterman Harold Alexander<sup>20,33,34</sup>.



Fig 3. Col. Edward D. "Pete" Churchill on August 30, 1943, during a tour organized by the Red Cross. Photograph of Edward D. Churchill in Cairo [HMS c62, box 34, f.3] from the Edward D. Churchill Papers, The Harvard Medical Library in the Francis A. Countway Library of Medicine, reproduced with permission<sup>32</sup>.

The Red Cross was helping the ABTS with production of whole blood in the Middle Eastern theater. Col. Churchill is accompanied by Mrs. Charlotte R. Bonner of the Red Cross. The previous day, Col. Churchill had met Mr. Banes, Director of the U.K. Red Cross in the Middle Eastern Theater, who assigned Mrs. Bonner as Col. Churchill's Cairo guide. She took Col. Churchill to the Middle East Surgeon's office where they worked on vital statistics of the wounded. They then went to British General Hospital No. 9 to see British Major Andrew Logan's group of chest injury patients, and continued on to British Hospital No. 63, together with Major Logan of Edinburgh and Col. J.S.K. Boyd. Churchill's camel's name was "Canada Dry". On August 31, 1943, Churchill left Cairo to return to his North African Post and thence to Italy: the Allies landed at Salerno on September 9, 1943<sup>32,33</sup>.

### BRITISH NEAR BANKRUPT

During early 1944 Winston S. Churchill's government were presented draconian terms and demand for the termination of Lend-Lease: on March 9, 1944, W.S. Churchill replied to President Roosevelt regarding U.K. dollar holdings: "These

U.K. dollar balances are not, as your telegram might suggest, a particular part of our assets...but our total reserves... We alone of the Allies will emerge from the war with great overseas war debts. I do not know what would happen if we were now asked to disperse our last liquid reserves at a time when British and American blood will be flowing in broad and equal streams and when the shortening of the war by even a month would far exceed the sums under consideration"<sup>35</sup>. President Roosevelt, in response to many in Congress and his administration, decided to temporize, having in mind the Octagon Conference and his own upcoming presidential election<sup>36</sup>.

Initially, the D-Day Casualty Planning Committee had planned for the 30,000 pints of group O whole blood to last until the expected breakout from Normandy. The Whitbys tried to increase their collection of whole blood by donor drives by the ABTS and blood banks, especially in Cairo, Algiers, London and Belfast (Fig.3). The U.S. Armed Forces in the U.K. bled essentially every one of their available, non-combatant troops. With the unavailability of whole blood from the United States, the fighting in the Normandy bocage exhausted U.S. supplies. This dire situation was exacerbated by the RAF and USAAF short bombing of U.S. Troops before the Saint-Lô breakout. ABTS was thereafter chiefly responsible for the supply of whole blood to the Allied forces until after the Allied liberation of Brussels on September 3, 1944<sup>19,20</sup>. One of the keys to ABTS success was the widespread enlistment of French donors both in North Africa and metropolitan France. Almost total Allied air-superiority and a plethora of a thousand DC3 Dakotas helped immeasurably—wounded going north and ABTS blood going south, averaging 2,000 pints per day. The number of wounded reached 40,000 in a single month, and as many as 50,000 patients were air-evacuated. Nonetheless, the U.S. Armies in Normandy had to ration and allocate whole blood despite the provision to these U.S. armies of several thousands of pints of whole blood by ABTS. On the instruction of the European surgical consultants and Lieut. General Sir Alexander Hood, GBE, head of the R.A.M.C., Generals Paul Hawley and Harvard's Moseley Professor of Surgery, Elliott C. Cutler, were flown to Washington on August 13, 1944. The U.S. Surgeon General Kirk and General Hap Arnold, Commander U.S.A.A.F. changed their position while Hawley and Cutler were in mid-Atlantic. On August 21, 1944, the first pints of whole blood were flown from New York to U.S. forces in Europe. During the transition period in the fall of 1944, to compensate for U.S. inexperience in temperature control for transported whole blood, U.S.A.A.F. pilots were instructed to fly trans-Atlantic at six to eight thousand feet to preserve blood at 4 - 6°C<sup>19,20</sup>.

### OCTAGON TUITION

On Tuesday, September 5, 1944, Lionel Whitby joined Winston and Clementine Churchill's family party on the Cunard liner *Queen Mary*, en route to the Quebec Conference known as "Octagon". On Wednesday, September 6, Lionel Whitby was asked to dine en famille with W.S. Churchill

and Hastings (Pug) Ismay. Churchill suggested that Whitby instruct the "Yanks how to fly blood long-ways big time" in Quebec<sup>37</sup>. At that September 6 dinner, Whitby recounted the R.A.F.'s dropping of whole blood to the ongoing Polish insurrection in Warsaw, which had started the previous month on August 1. Ismay suggested that Whitby also describe A.B.T.S.'s services to the U.S. personnel in Normandy, the rest of France, North Africa, Sicily, Salerno and Anzio.

Winston Churchill knew of his namesake Pete's briefing by the U.S. Surgeon General Magee and his staff in January 1943. Sir Alexander Hood had told him how the Pete Churchill legend had begun in 1929 at Harvard, with Pete's first successful U.S. pericardiectomy—the stripping of the pericardium in a patient dying of constrictive pericarditis<sup>27,38</sup>. W.S. Churchill added that he had learnt more of Robby Robertson and Elliott Cutler in World War I at the Club of Odd Volumes, watering hole of bibliophile Brahmins, after receiving his Honorary Harvard LLD on September 6, 1943<sup>26,39</sup>.

The *Queen Mary* docked in Halifax on Sunday, September 10, 1944 and the Octagon conference started in Quebec City on Tuesday, September 12 (Fig. 4). After Whitby's presentations, President Roosevelt told Admiral Leahy to tell Brigadier Whitby he should hereafter "request and require on behalf of the Commander-in-Chief" (as Ismay told JHW). Thus, on Thursday, September 14, Admiral Leahy came as the sole American, to Churchill's "vast household dinner"<sup>42\*</sup>. Later that evening, Churchill told his secretary Colville that their gambit "our blood for your money" had, as Colville put it, succeeded "beyond the dreams of avarice". Winston Churchill replied, "Beyond the dreams of justice"<sup>42</sup>.

On Sunday, September 17, the Winston Churchills left for Hyde Park. On Wednesday, September 20, the Churchill party and 9,000 U.S. troops left New York, again on *The Queen Mary*. At Churchill "domestic" dinner parties on Thursday, September 21, finishing at 3:00 a.m. and on Sunday, September 24, Whitby was debriefed by Churchill in his "old spontaneous form"<sup>42</sup>. President Roosevelt was no longer proposing British bankruptcy. During the Battle of the Bulge in December 1944 and January 1945, A.B.T.S. was again given control of all west European blood matters. Montgomery and Patton were delighted that U.S. three-star general Lee no longer, at least temporarily, had a say in blood transport and distribution<sup>43</sup>.

### PACIFIC WAR

U.S. blood transport and preservation were a shambles at Leyte—essentially all blood was destroyed by tropical heat. In all, about 3,000 pints of preserved whole blood were used during the first thirty days of the Leyte liberation<sup>19,20,44</sup>.

\* During 1915-1916, Leahy and F.D.R. had frequently sailed together on the East Coast as far as Campobello. F.D.R. in 1916 dispatched Leahy in the Dolphin, the Secretary of the U.S. Navy's dispatch boat, to pick up F.D.R.'s family at Campobello and sail them up the Hudson to their home in Hyde Park, New York. Leahy discretely completed this 600 mile sail.



At Iwojima there was a shortage of whole blood for both wounded marines on land and on board U.S. Navy ships. Okinawa was different: for 46,000 U.S. wounded, 46,000 pints of whole blood were successfully transported, preserved and transfused. Whitby's 1940 estimate of 41.4 had become 100 pints of whole blood per 100 wounded<sup>2</sup>. Between March 24 and the middle of June 1945, the American Army Divisions lost 4,000 killed on Okinawa and the U.S. Marine Corps reported almost 3,000 dead. Japanese army casualties were 110,000 dead. The Japanese lost 7,800 planes around Okinawa, of which 1,000 were kamikaze. Okinawan civilian casualties were at least 70,000, and possibly as many as 160,000<sup>19,45</sup>.



*Fig 4.* This photograph was taken on the boardwalk of the Citadel near the Château Frontenac, Quebec City, when the U.S. Joint Chiefs of Staff met with the British Chiefs of Staff as the Allies' Combined Chiefs of Staff Committee at the Octagon Conference in September 1944. Seated (left to right) are General George C. Marshall, Admiral William D. Leahy, President Franklin D. Roosevelt, Prime Minister Winston S. Churchill, Field Marshal Sir Alan Brooke, and Field Marshal Sir John Dill; standing (left to right) are Brigadier Leslie C. Hollis, Lieutenant General Sir Hastings Ismay, Admiral Ernest J. King, Air Chief Marshal Sir Charles Portal, General Henry H. Arnold Chief of the U.S. Army Air Corps, and Admiral Sir Andrew B. Cunningham.

Leahy was instructed by U.S. Commander in Chief Franklin D. Roosevelt to tell Brigadier Lionel E. Whitby, also present at the Château, that it was F.D.R.'s wish that henceforth the advice of the Whitbys be followed in all Allied areas of combat. Leahy was Chair of the U.S. Joint Chiefs of Staff and Chief of Staff to the Commander in Chief, F.D.R.

Both Alan Brooke and Bill Leahy suffered grievously in World War II. Twelve of twenty-seven "Fighting Brookes of Colebrooke", County Fermanagh, were killed<sup>40</sup>. Louise Leahy died postoperatively in Vichy, France, on April 21, 1942, after F.D.R. had urgently recalled her husband of thirty-eight years from his ambassadorship to Pétain, following Laval's assumption of power. The Leahys had planned to return to Washington, D.C. as soon as Mrs. Leahy had sufficiently recovered, but Admiral Leahy embarked for New York on May 22, 1942 with his wife's remains<sup>41</sup>.

U.S. Army Signal Corps photograph 194469 2. Courtesy of the George C. Marshall Foundation, Lexington, Virginia, USA.

Presidential and U.S. chiefs of staff estimated that the casualties during the invasion of Japan would amount to 268,000 of the 767,000 of the U.S. troops committed, and therefore they needed 300,000 pints of blood<sup>45</sup>. Blood and plasma, 100,000 pints of each, were ready<sup>19</sup>. After VJ day, the Japanese and Allied prisoner burns survivors were recipients of this trove: there were between 500,000 and one million burns survivors of the U.S. bombing raids<sup>46,47</sup>. Transfusions began as occupation forces arrived.

The American Red Cross collected 13.3 million pints of donor blood during World War II, of which 10.3 million was converted into plasma and 3 million into whole blood: of this, soon after the liberation of Brussels, 197,712 pints of whole blood were flown from the U.S.A. to the Allied forces in Europe<sup>19</sup>. Using ABTS cooling techniques only 3-4% were spoiled and only another 4,000 pints discarded as past expiration date.

## POST WAR

In November 1946, Brigadier Lionel Whitby became visiting Professor of Medicine at Harvard University, and subsequently Regius Professor of Physic and Vice Chancellor, Cambridge University<sup>48,49</sup>. On May 17, 1946, Elliott Cutler addressed the Annual Meeting of the Academy of Medicine, Cleveland, Ohio, saying, "I do not believe the American People will tolerate in another war the entirely secondary position relegated to the medical department by many generals in this war, as if the lives of American citizens were totally expendable<sup>50</sup>". Professor Cutler died of cancer on August 16, 1947.

In 1948, J.H. Biggart, having been overlooked in the Churchill's 1945 dissolution honours, was appointed C.B.E. by Atlee's Labour administration. The citation stated the award was for his part in "organizing the Blood Transfusion Service and emergency medical services in Northern Ireland"<sup>18</sup>.

On August 12, 1959, John Hedley-Whyte was appointed Clinical Fellow, Acting Resident at the Massachusetts General Hospital; on December 18, 1961, he was appointed to Professor Edward D. "Pete" Churchill's Harvard Department of Surgery as an Assistant.

Donegal-born Magee's wife died in 1946. He thereafter lived at the Army-Navy Club in Washington, D.C., by day mostly in a corner arm-chair. John Hedley-Whyte, when staying there was told by staff that the Army Surgeon General always warmly greeted his sons, General Mervyn M. Magee, and Col. James C. Magee, Jr., Marine Corps and two grandchildren on their frequent visits. Army Surgeon General Magee was buried with full U.S. Military Honours in Arlington National Cemetery on 20 October 1975<sup>21</sup>.

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